

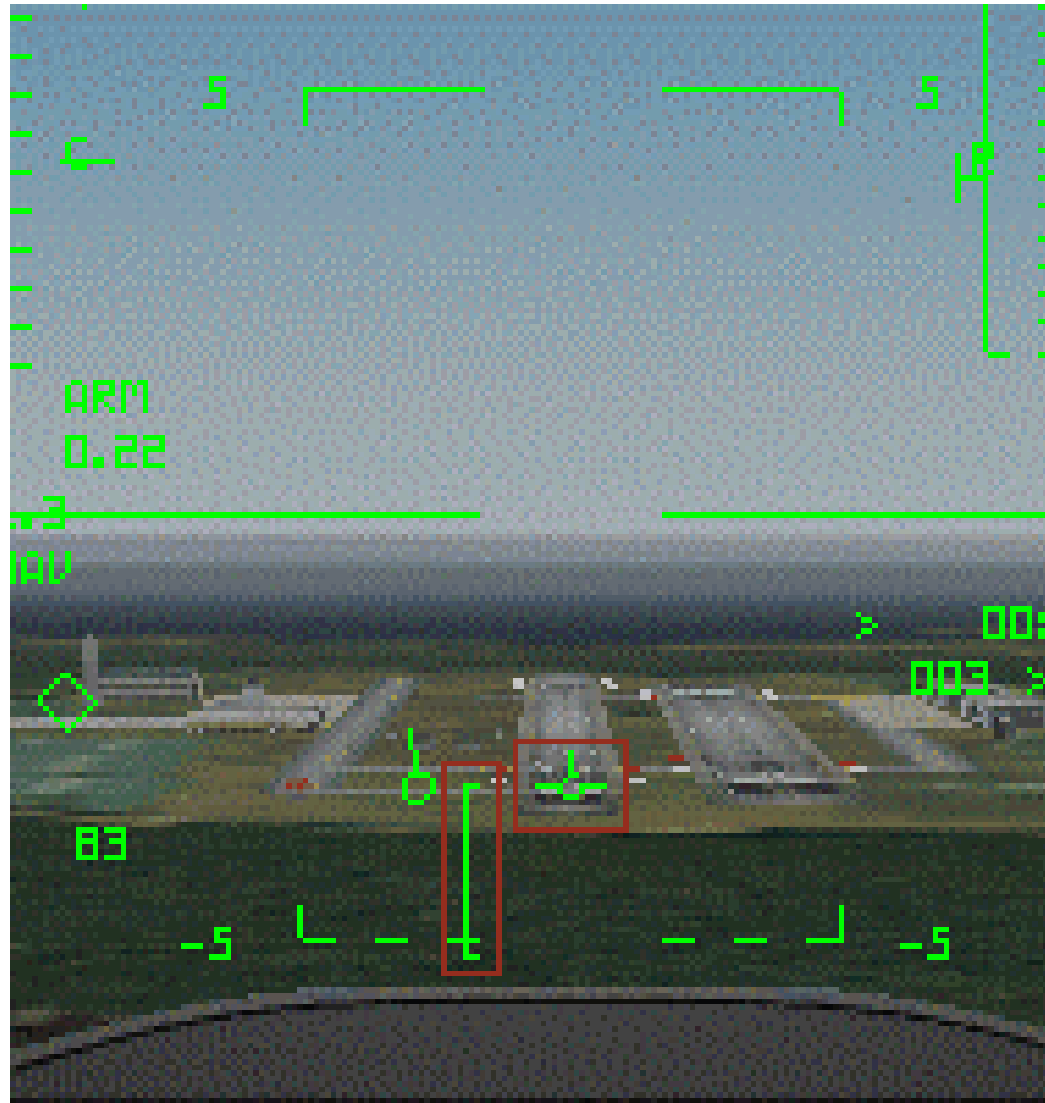
Advanced Flight Display For General Aviation Aircraft: A Cost-Effective Means to Enhance Safety

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Typical Instrumentation





Ref: <http://msnhomepages.talkcity.com/msngamingzone/crazyammo/landing.html>



Introduction

- **Comment**

- » The 'instruments' in use today for GA have undergone virtually negligible changes in fifty-plus years

- **Objective**

- » To design an advanced flight display for the general aviation pilot to increase SA in IMC flight, thus increasing safety

- » To provide an initial assessment of the display concept for GA (Is this approach valid?)



Introduction (cont'd)

- **Concerns**
 - » **Cost versus Capability**
 - » **Simple enough that it can be flown by the average low-time GA IFR pilot**
- **Design**
 - » **Velocity vector based positioning and orientation**
 - » **DELPHINS display software**



Motivation

- **Provide Visual Cues in IMC**
- **Reduce pilot training and recurrency requirements for flight in IMC**
- **Produce ‘virtual VMC’ in the cockpit**
- **Keep the pilot looking out-the-window at the same time he/she is flying the instrument approach**



Overview of the eHUD

- **An enhanced head-up type of display**
- **Flat panel display mounted on top of the dashboard of the plane**
- **The flat panel projects a mirror image of the flight display onto the windshield**
- **The resulting image on the windshield allows for simultaneous viewing of the display and the out-the-window environment**



Design Issues

- **Accuracy**
 - » Must accurately depict the external environment and aircraft state
- **Affordability**
 - » Develop using existing technologies
 - GPS
 - DELPHINS
- **Simplistic**
 - » Training requirements must be minimal



Velocity Vector Based Orientation

- **Developed by Dr. Kornfeld, Dr. Hansman and Dr. Deyst at MIT**
 - » Also known as single-antenna GPS-based attitude determination
- **Pseudo Roll, Flight Path Angle & Ground Track Angle**
 - » Referenced about the velocity vector with respect to local horizon
 - » Pseudo Roll based on acceleration derived from GPS velocity



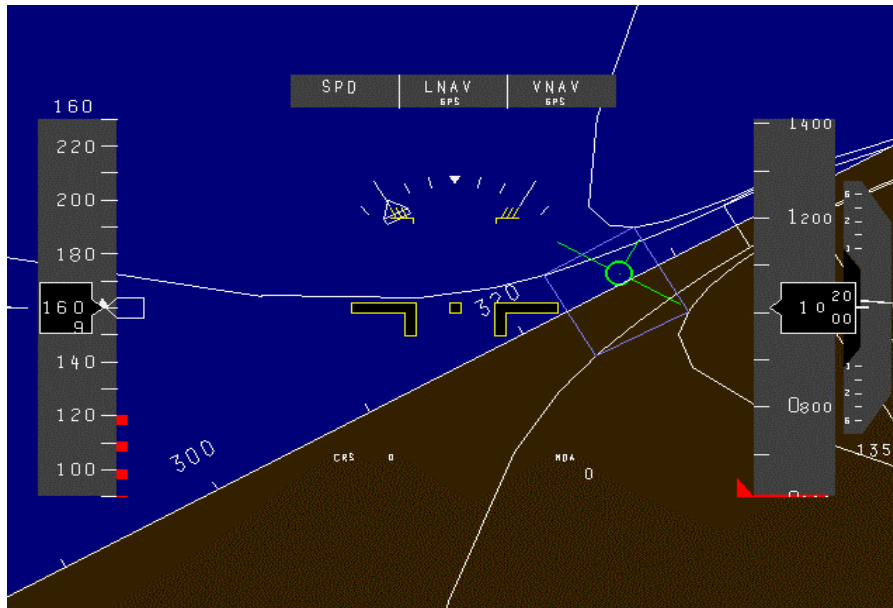
DELPHINS

- **‘Tunnel-in-the-sky’ display technology**
- **Pioneered by Erik Theunissen at the Delft University of Technology, The Netherlands**
- **Three-dimensional representation of the outside world allows for more intuitive control of the aircraft**



Flight Test Setup

Display



GPS Antenna



Display
Processor

Real-Time
Processor

NovAtel Rx



Flight Test Setup

- **Piper Saratoga (PA-32)**
 - » **Single engine**
 - » **Six Seats**
- **CyberResearch Inc Industrial Computer**
 - » **Windows operating system**
 - » **3Dfx graphics card**
 - » **Ethernet card**



Flight Test Setup

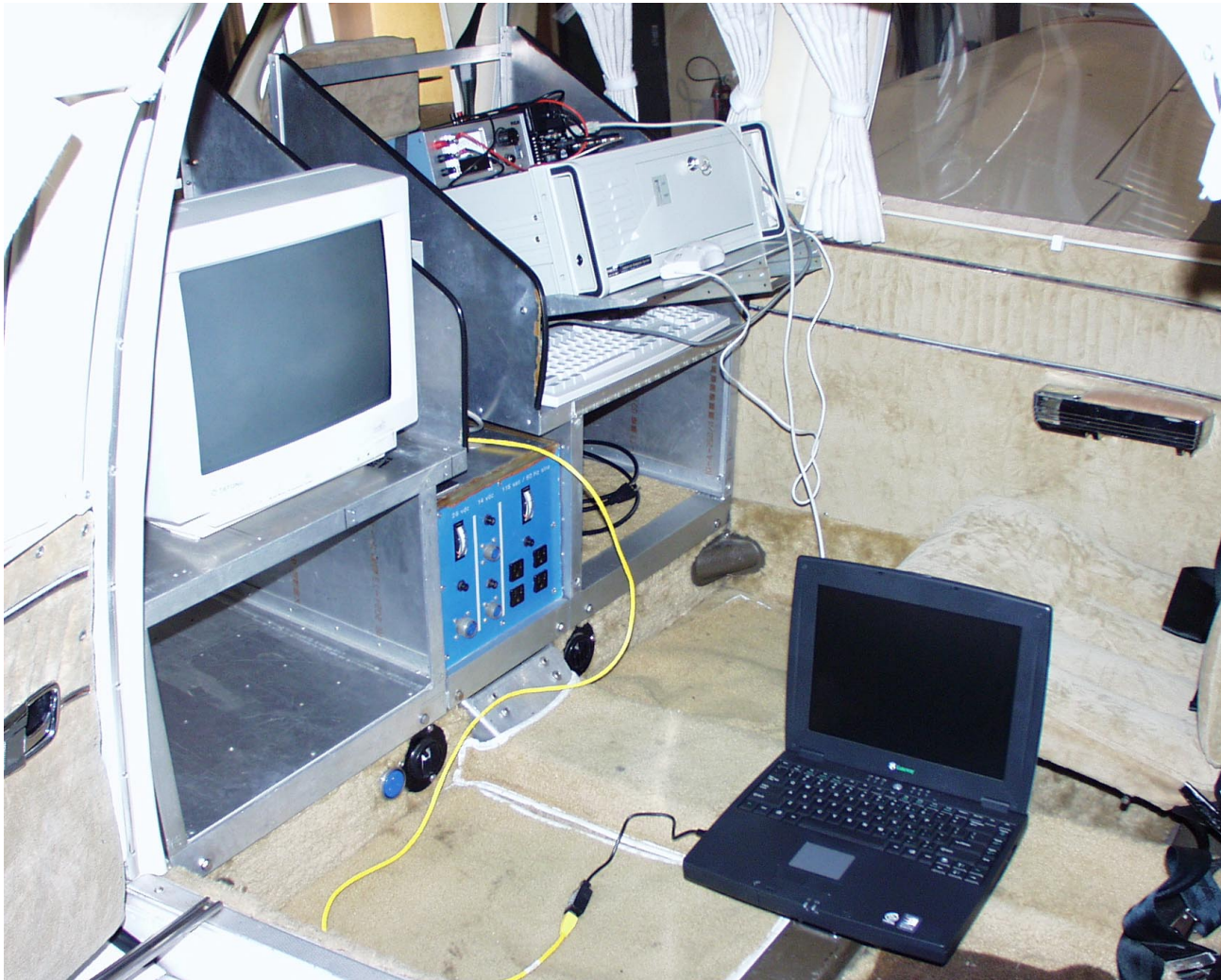
- **Gateway 600 MHz Laptop**
 - » QNX
 - » PCMCIA card
- **2 Monitors**
 - » Software Initialization and Monitoring
 - » Display Presentation
- **NovAtel GPS Receiver**
- **Power Supply for active GPS Antenna**



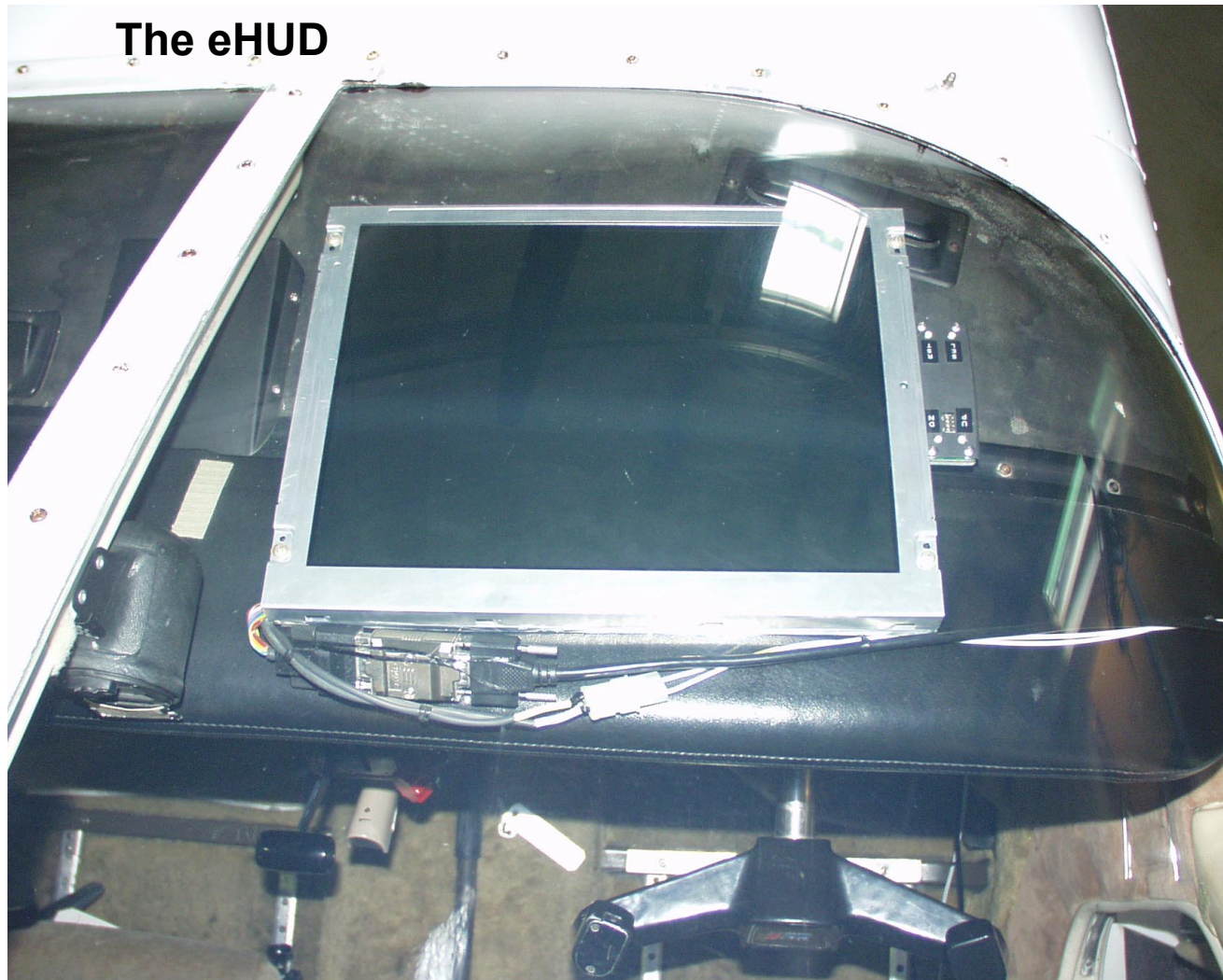
Flight Test Setup



Flight Test Setup



Flight Test Setup



Flight Test Results

- **Verified MIT's conclusion that single-antenna GPS can provide accurate attitude measurements to drive an approach flight display**
- **The eHUD is a feasible way to allow the pilot to follow the display and simultaneously look for the runway**



Future Work

- **Install NovAtel OEM4 with 20 Hz position and velocity**
- **Investigate Projection methods**
 - » **Minimize installation time, effort and cost**
 - » **Consider use of a hinged-window**
- **Human Factors**
 - » **Optimal terrain depiction, use of symbols**
 - » **Workload Assessment; Situational Awareness**
 - » **Depth Perception; Image Scaling**

